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(54) **ACCESS CONTROL VIA A MOBILE DEVICE**

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(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,672,654 A 6/1987 Vanacore

7,969,302 B2 6/2011 Srinivasa et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 104144497 A 11/2014

EP 2085934 A1 8/2009

OTHER PUBLICATIONS

Fave et al., "Game-theoretic Security Patrolling with Dynamic Execution Uncertainty and a Case Study on a Real Transit System," *Journal of Artificial Intelligence Research* 50, Jun. 2014, 47 pp.

(Continued)

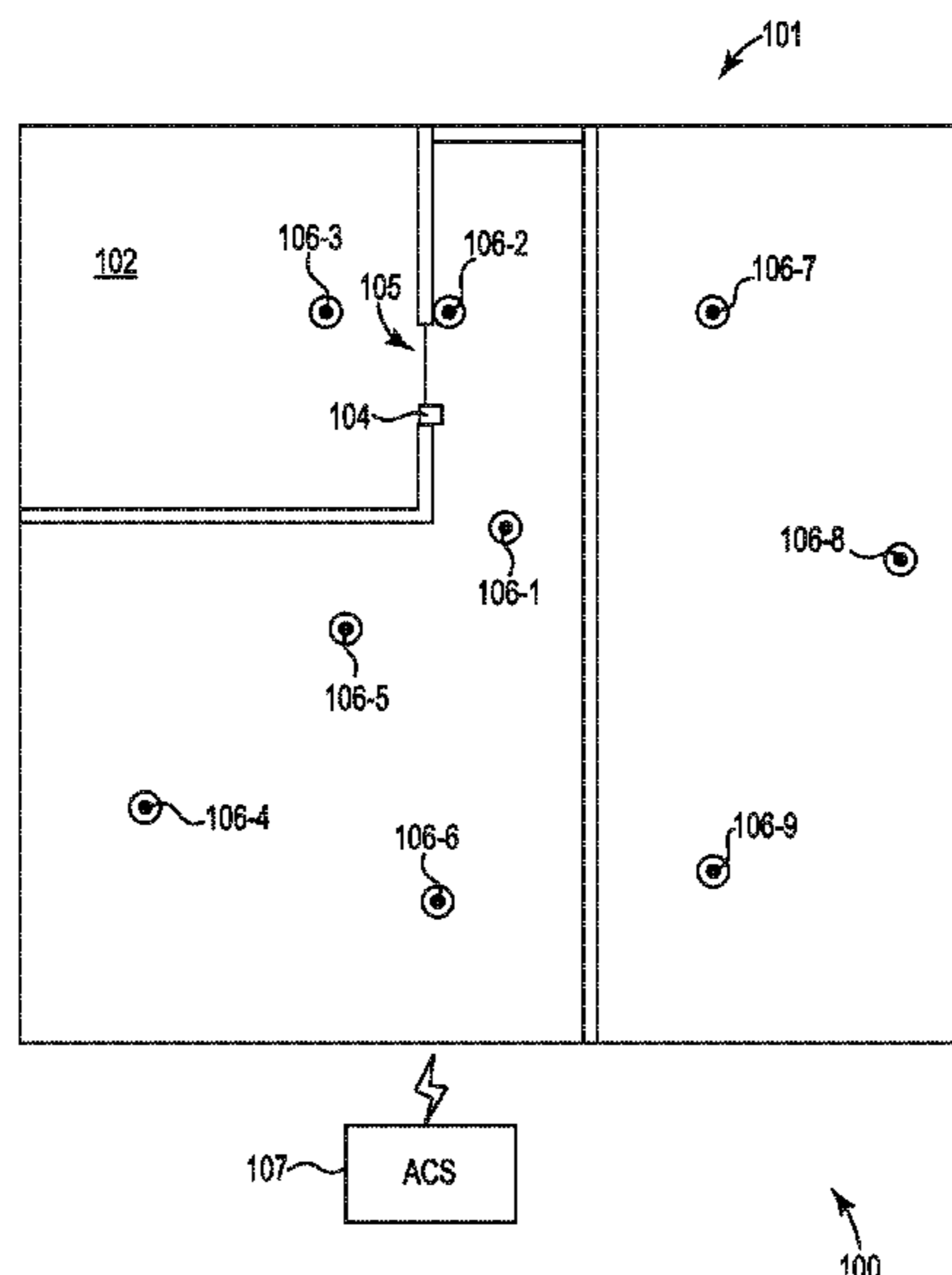
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(57) **ABSTRACT**

Systems, devices, and methods for access control via a mobile device are described herein. One device includes instructions stored thereon executable by a processor to track a location of a mobile device in a facility based on communications between the mobile device and a plurality of beacons located in the facility, wherein the mobile device is associated with a particular user having access rights associated with the facility, determine that the mobile device is located in a particular area of the facility, determine whether the user is allowed access to the particular area based on the access rights, and provide a notification responsive to a determination that the user is not allowed access to the particular area.

20 Claims, 5 Drawing Sheets



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2013/0021145 A1 1/2013 Boudy
 2013/0314210 A1 11/2013 Schoner et al.
 2014/0049361 A1* 2/2014 Ahearn G07C 9/00309
 340/5.7
 2014/0342667 A1 11/2014 Aamio
 2014/0375421 A1 12/2014 Morrison et al.

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G07C 2009/00769 (2013.01); *G07C 2209/63*
 (2013.01)

OTHER PUBLICATIONS

“Logosoft brings lone worker supervision into the Android era,”
<http://www.securitynewsdesk.com/logosoft-brings-lone-worker-supervision-android-era/>, May 29, 2014, 7 pp.
 Sookman “Smartphones are Key to the Future of Security,” <https://www.guardly.com/blog/2015/02/04/smartphones-are-key-to-the-future-of-security/index.html>, Feb. 4, 2015, 5 pp.
 Bobescu et al., “Mobile indoor positioning using wi-fi localization,”
 Review of the Air Force Academy, 2015, No. 1 (28), 4 pp.
 Bhargava et al., “Physical Authentication through Localization in
 Wireless Local Area Networks,” Global Telecommunications Conference, GLOBECOM '05 IEEE, Jan. 23, 2006, 5 pp.
 “Passive Entry Door System with Proximity Sensor,” http://www.atmel.com/Images/Atmel-42582-Passive-Entry-Door-System-with-Proximity-Sensor_Application%20Note_AT12649.pdf, Nov. 2015, 22 pp.
 Bellido-Outeirno, “Universal Bluetooth Access Control and Security System,” International Journal on Advances in Security, 2011, vol. 4 No. 3 and 4, 10 pp.

- (58) **Field of Classification Search**
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- (56) **References Cited**
 U.S. PATENT DOCUMENTS

9,058,702 B2 6/2015 Chao et al.
 9,076,273 B2 7/2015 Smith et al.
 9,444,805 B1 9/2016 Saylor et al.
 9,514,469 B2 12/2016 Fuchs et al.
 9,713,002 B2 7/2017 Roy et al.
 2005/0242957 A1 11/2005 Lindsay et al.
 2009/0249433 A1 10/2009 Misra et al.
 2010/0102993 A1 4/2010 Johnson
 2011/0291798 A1 12/2011 Schibuk

* cited by examiner

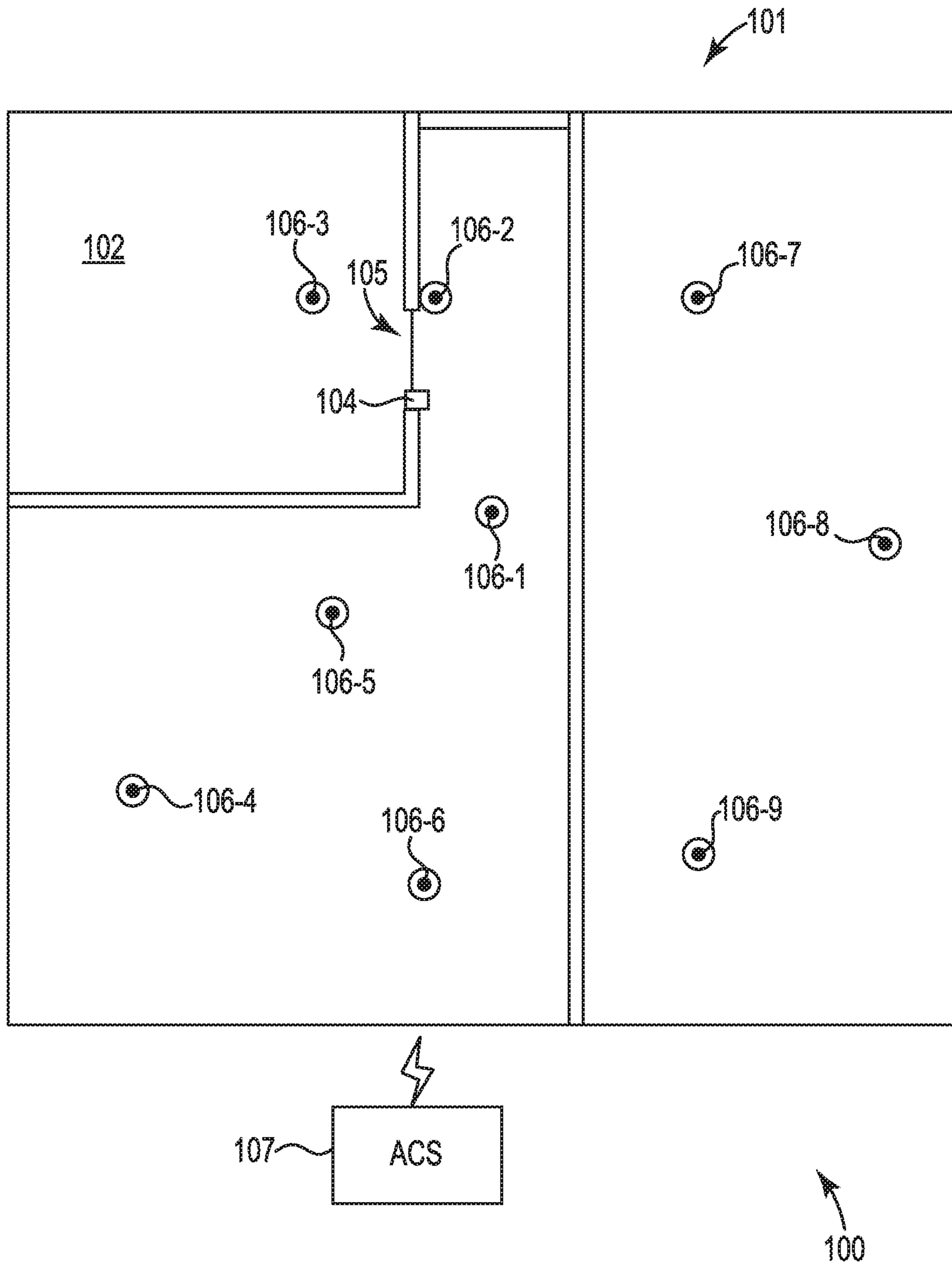


Fig. 1A

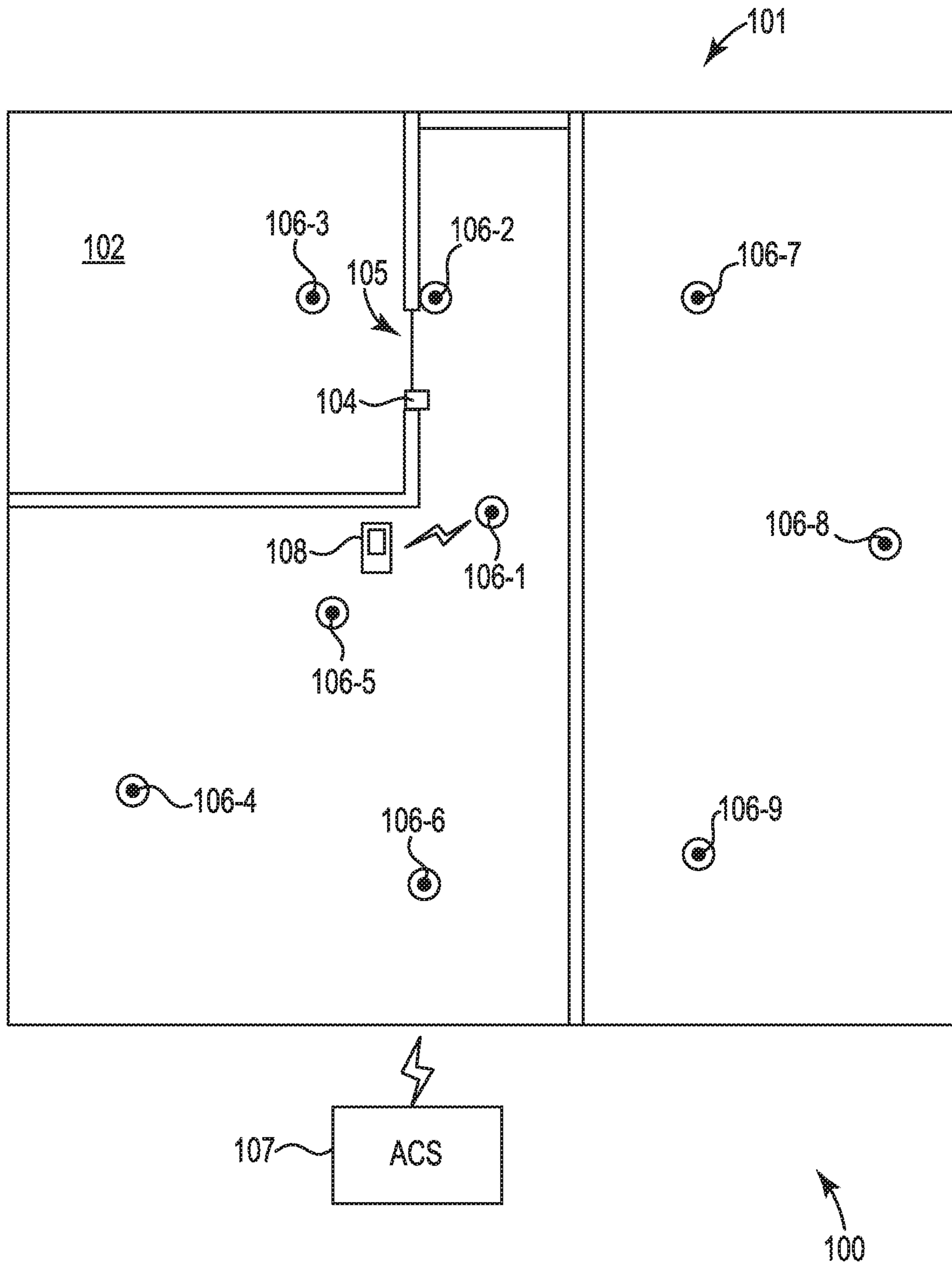


Fig. 1B

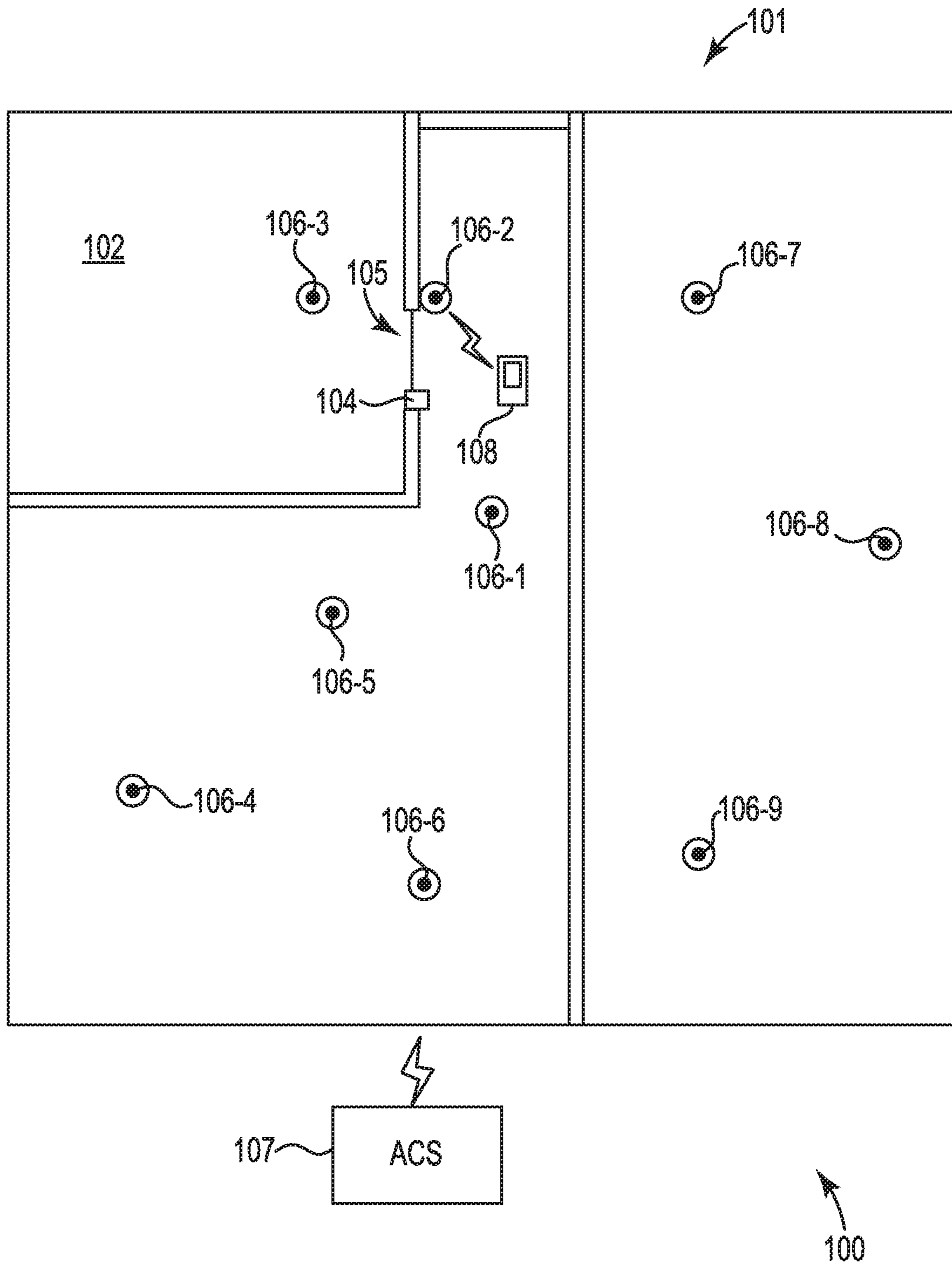


Fig. 1C

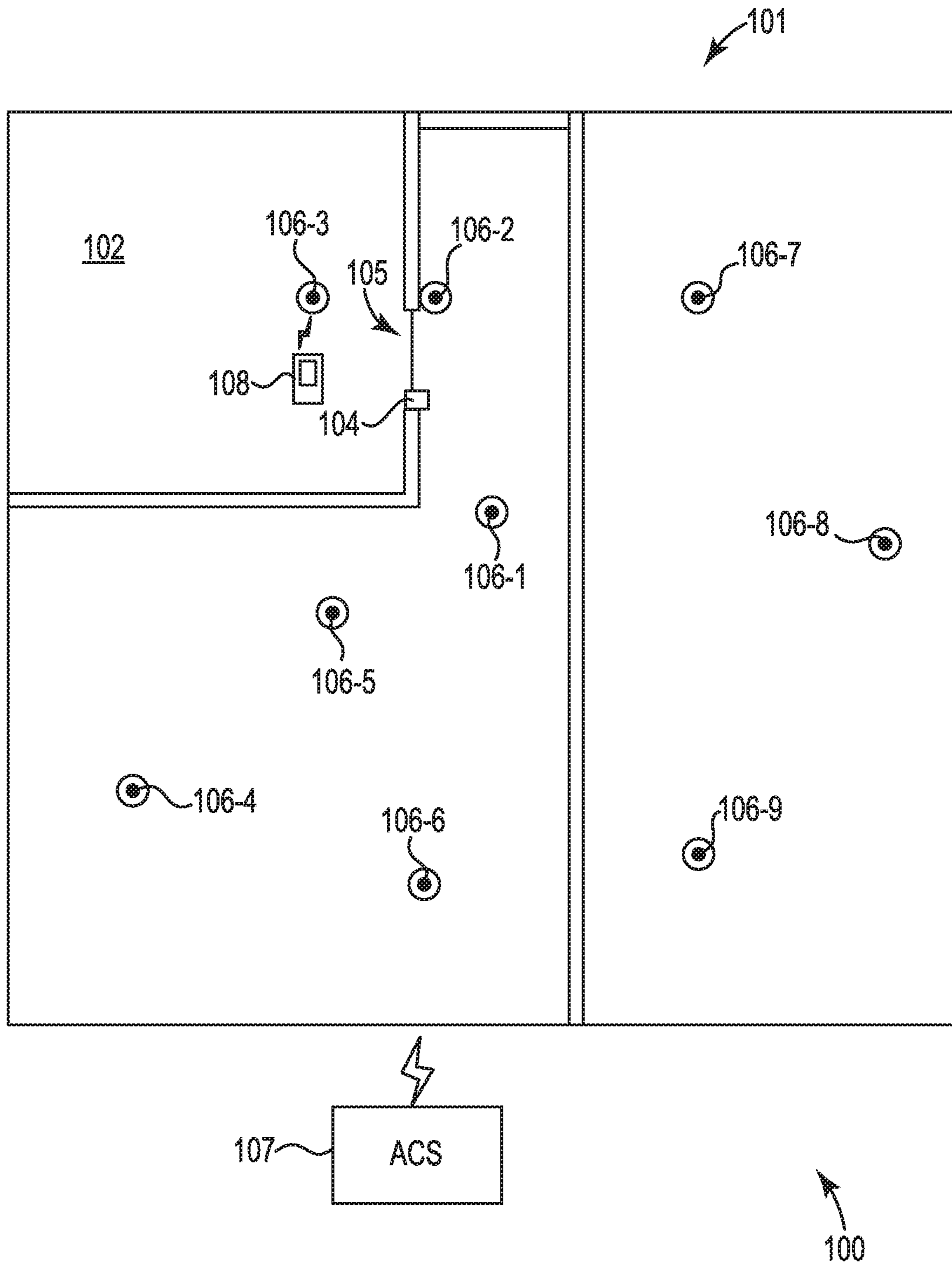


Fig. 1D

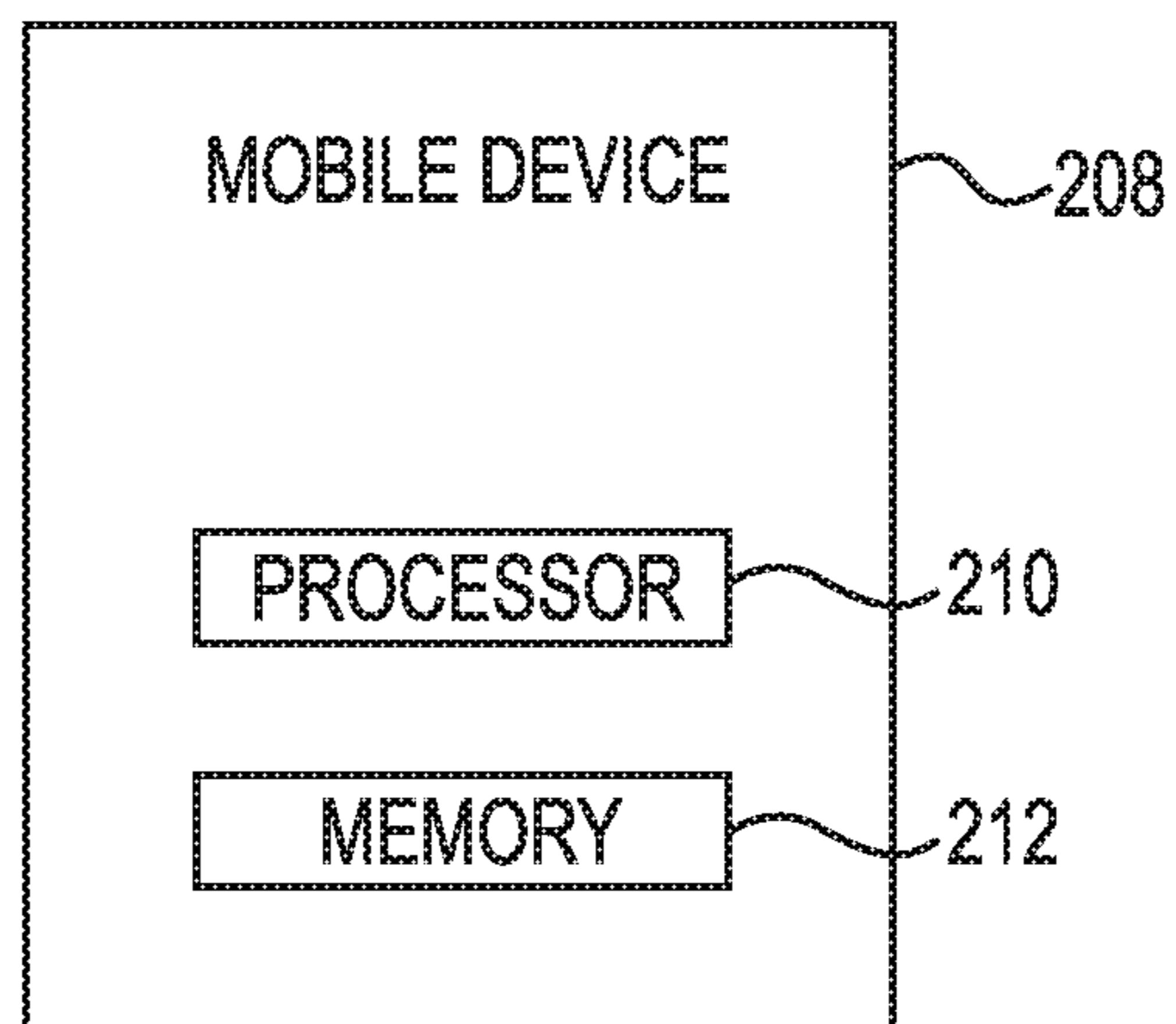


Fig. 2

ACCESS CONTROL VIA A MOBILE DEVICE

This is a continuation of co-pending U.S. patent application Ser. No. 15/356,329, filed on Nov. 18, 2016, which is incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to systems, devices, and methods for access control via a mobile device.

BACKGROUND

Access control systems are designed to provide access to areas of a facility for individuals who are authorized to access such areas, and deny access to those areas of the facility to individuals who are not authorized to access such areas. For example, certain individuals may be authorized to access a secure area of a facility, whereas other individuals may not be allowed to access the secure area.

Previous approaches to access control systems may use physical access cards. Carrying a physical access card may be cumbersome. A user may be locked out of an area if the user forgets to carry the physical access card, and an unauthorized user may gain access to a secure area because the access control system cannot verify the physical identity of the user carrying the physical access card.

Additionally, previous approaches may not link an access control system with a physical access card to track the card within the facility in that the physical access card may be disconnected from the system until the user manually displays the card to an access reader, for instance. Moreover, a person may not use the card (intentionally or unintentionally) and gain access to an area of a facility by following another person in.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A illustrates a system for access control via a mobile device in accordance with one or more embodiments of the present disclosure.

FIG. 1B illustrates the system for access control via a mobile device wherein a mobile device is located at a first location in accordance with one or more embodiments of the present disclosure.

FIG. 1C illustrates the system for access control via a mobile device wherein the mobile device is located at a second location in accordance with one or more embodiments of the present disclosure.

FIG. 1D illustrates the system for access control via a mobile device wherein the mobile device is located at a third location in accordance with one or more embodiments of the present disclosure.

FIG. 2 illustrates a mobile device in accordance with one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

Access control via a mobile device is described herein. For example, one or more embodiments include a computer-readable medium having instructions stored thereon executable by a processor to track a location of a mobile device in a facility based on communications between the mobile device and a plurality of beacons located in the facility, wherein the mobile device is associated with a particular user having access rights associated with the facility, determine that the mobile device is located in a particular area of

the facility, determine whether the user is allowed access to the particular area based on the access rights, and provide a notification responsive to a determination that the user is not allowed access to the particular area.

Embodiments of the present disclosure can effectively replace a user-carried physical access card and access control system hardware devices with a mobile device. By using a mobile device—something most users typically already carry—embodiments of the present disclosure can provide increased security while streamlining user interaction with the access controls system. Additionally, embodiments herein can reduce costs by obviating the need for expensive hardware devices to verify user identities.

Increased security can be provided through capabilities offered by mobile devices. In some embodiments, users (i.e., the user's mobile device) can be assigned a digital identity (discussed further below). The digital identity can allow the mobile device, instead of a physical hardware access controller, to control access, for instance.

Increased security can be provided by maintaining a connection between a mobile device and a centralized physical security system (herein referred to as “access control system”). User interaction with the access control system can be streamlined via capabilities offered by mobile devices. In some embodiments, global positioning system (GPS), WiFi, and/or other location functionalities provided by the mobile device may allow the automatic determination of user location (e.g., without user input). Thus, rather than physically presenting a card (or other device) for access to an area, the user can simply draw within a particular distance of the area.

That is, whereas previous approaches may utilize “card readers,” which typically call for a user to present a card (e.g., badge and/or other token), read the card, then transmit a signal physically to an access controller to make an access determination (e.g., whether the user is allowed access), embodiments of the present disclosure can allow the mobile device itself to effectively become the card. Then, the “card” can be presented to a “reader” by virtue of the mobile device being in a particular physical location (or within a particular distance of a particular physical location).

By tracking the location of a mobile device associated with a user, embodiments of the present disclosure can determine if a user has entered an area to which the user is not allowed access. In some cases, such entry can be the result of “tailgating,” for instance. Tailgating refers to a person intentionally or unintentionally following another person through a secured door into an area. Because access is granted only to the first person, previous approaches to access control may not even be aware that the tailgater has entered the area.

Embodiments herein can determine when a person has entered an area to which they are not allowed access by tracking their mobile device. When a person is determined to have entered such an area, one or more actions may be taken. In some embodiments, a notification may be sent to the mobile device. In some embodiments, a notification may be sent to a computing device. In some embodiments, security personnel may be dispatched in order to make contact with the person.

In the following detailed description, reference is made to the accompanying drawings that form a part hereof. The drawings show by way of illustration how one or more embodiments of the disclosure may be practiced.

These embodiments are described in sufficient detail to enable those of ordinary skill in the art to practice one or more embodiments of this disclosure. It is to be understood

that other embodiments may be utilized and that process, electrical, and/or structural changes may be made without departing from the scope of the present disclosure.

As will be appreciated, elements shown in the various embodiments herein can be added, exchanged, combined, and/or eliminated so as to provide a number of additional embodiments of the present disclosure. The proportion and the relative scale of the elements provided in the figures are intended to illustrate the embodiments of the present disclosure, and should not be taken in a limiting sense.

The figures herein follow a numbering convention in which the first digit or digits correspond to the drawing figure number and the remaining digits identify an element or component in the drawing. As used herein, “a” or “a number of” something can refer to one or more such things. For example, “a number of areas” can refer to one or more areas.

FIG. 1A illustrates a system **100** for access control via a mobile device in accordance with one or more embodiments of the present disclosure. As shown in FIG. 1, system **100** a plurality of beacons in a facility **101**. Nine beacons are illustrated in FIG. 1A, though it is noted embodiments of the present disclosure are not limited to a particular number of beacons. The beacons include a beacon **106-1**, a beacon **106-2**, a beacon **106-3**, a beacon **106-4**, a beacon **106-5**, a beacon **106-6**, a beacon **106-7**, a beacon **106-8**, and a beacon **106-9**, and are cumulatively referred to herein as “beacons **106**.”

The beacons **106** can be devices capable of wireless communication with a mobile device **108**. In some embodiments, one or more of the beacons **106** can be associated with (e.g., located proximal to) the relay **104**, the door **105**, and/or the area **102**. For instance, the beacon **106-2** is located proximal to the door **105** (e.g., within 5 feet of the door **105**). The beacons **106** can allow the determination of a location of a mobile device **108** in the facility **101**. For example, the beacons **106** can allow the determination of whether a mobile device **108** is within a particular (e.g., threshold) distance of the area **102** and/or the door **105**. The beacons **106** can communicate with a mobile device **108** via Bluetooth Low Energy (BLE) technology (e.g., as an iBeacon), WiFi, etc. In some embodiments, the beacons **106** can include one or more readable tags (e.g., near field communication (NFC)) tags.

A facility, as used herein, can refer to one or more buildings, businesses, homes, plants, hospitals, refineries, etc. The facility **101** can include indoor and/or outdoor areas. The facility **101** includes an area **102**. The area **102** can be a portion of the facility **101**. In some embodiments, the area **102** can be a room, a plurality of rooms, a wing, a building, a plurality of buildings, an installation, etc. In some embodiments, the area **102** can be defined by physical boundaries (e.g., walls, doors, etc.). In some embodiments, the area **102** can be defined by logical and/or geographic boundaries. The area **102** can be defined by a user, by a Building Information Model (BIM) associated with the facility **101**, and/or by an access control system.

The area **102** may be a restricted area and/or an area requiring access rights for entry. Entry into and/or exit from the area **102** can be made via a door **105**. Unlocking of the door may be performed by a relay **104**. The relay **104** can be a device allowing remote control that can be actuated by variation in conditions of one or more electric circuits. In some examples, the relay **104** can be a locking device. In some examples, the relay **104** can include one or more actuating mechanisms.

In some embodiments, control of the relay **104** may be provided from a mobile device **108**. In some embodiments, the control may be provided directly from a computing device (e.g., the ACS **107**, described below) or via one or more intermediary devices (e.g., a controller) in communication with the relay **104**.

Because, as described above, the “card” can be presented to a “reader” by virtue of the mobile device **108** being in a particular physical location (or within a particular distance of a particular physical location), embodiments of the present disclosure can implement the relay **104** in the absence of a controller (e.g., a local controller). That is, in some embodiments, the relay **104** does not include a controller. Various examples herein may refer to the relay **104** being a locking device for a door, but it is to be understood that such examples are not to be taken in a limiting sense; embodiments of the present disclosure do not limit relay **104** to a particular device.

The ACS **107** can be a computing device (e.g., a computing device having a processor and a memory, described below in connection with FIG. 2). The ACS **107** can control (e.g., manage) access to a number of areas (e.g., the area **102**) of the facility **101**. Though in the example illustrated in FIG. 1 the ACS **107** is shown external to the facility **101** (e.g., remote with respect to the facility **101**), embodiments of the present disclosure are not so limited. In some embodiments, the ACS **107** is internal to the facility **101** (e.g., local with respect to the facility **101**). In some embodiments, the ACS **107** can be cloud-based. In some embodiments, the ACS **107** can manage access to one or more areas across a plurality of facilities.

FIG. 1B illustrates the system **100** for access control via a mobile device **108** wherein a mobile device **108** is located at a first location in accordance with one or more embodiments of the present disclosure. The mobile device **108** can be a client device carried or worn by a user. For example, the mobile device **108** can be a phone (e.g., smart phone), personal digital assistant (PDA), tablet, and/or wearable device (e.g., wristband, watch, necklace, etc.).

The mobile device **108** can include one or more software applications (e.g., apps) which can define and/or control communications between the mobile device **108**, the ACS **107**, and/or other devices. Apps may be received by the mobile device **108** from the ACS **107**, for instance. Apps may be launched by a user and/or responsive to some other condition (e.g., the interaction between the mobile device **108** and a beacon (discussed below)). In some embodiments, apps can be executing as background apps. Apps may be and/or include a digital identity, discussed further below.

The mobile device **108** can communicate with (e.g., exchange data with) the ACS **107** via a wired and/or wireless connection, for instance. In some embodiments, the mobile device **108** can communicate using one or more communications modules (e.g., cellular, WiFi, etc.). The ACS **107** can communicate with the relay **104** via a wired and/or wireless connection, for instance. Communication between various devices herein can be carried out over a wireless network. A wireless network, as used herein, can include WiFi, Bluetooth, or any other suitable means to wirelessly transmit and/or receive information.

The mobile device **108** can include a location functionality configured to determine a location of the mobile device. In some embodiments, the location functionality includes a GPS and/or WiFi functionality of the mobile device **108**, though embodiments of the present disclosure are not so limited. For example, the mobile device **108** can include an imaging functionality (e.g., a camera) which can be used to

read a code at a particular (e.g., known) location in the facility **101**. In some embodiments, the mobile device **108** can utilize visual light communication (VLC) techniques to determine its position in the facility **101**.

Embodiments of the present disclosure can track a location of the mobile device **108** in the facility **101**. As discussed further below, the mobile device **108** can be associated with a particular user having access rights associated with the facility **101**. In some embodiments, the user may have access to some portions of the facility but not other portions (e.g., the area **102**). In some embodiments, tracking the location can include receiving location information by the ACS **107**. The location information can be provided as a particular geographic location (e.g., latitude/longitude) and/or a location with respect to another location, such as an area of a facility **101** or one or more of the beacons **106** of the facility **101**. In some embodiments, location information can be communicated from the mobile device **108**, and thus received by the ACS **107**, responsive to a communication being established between the mobile device **108** and one or more of the beacons **106**. In some embodiments, an indication that the mobile device **108** is within a particular distance of the area **102** can be received (e.g., as a request for access to the area **102**).

Embodiments of the present disclosure can determine that the mobile device **108** is located in the particular area **102** (e.g., based on a communication being established between the mobile device **108** and the beacon **106-3**, for instance. A determination can be made regarding whether the user associated with the mobile device **108** is allowed access to the area **102** based on access rights associated with the user.

In some embodiments, the determination of whether the user of the mobile device **108** is allowed access to the area **102** can be made by the mobile device **108**. In some embodiments, the determination of whether the user is allowed access to the area **102** can be made by the ACS **107**.

As discussed herein, the determination of whether the user of the mobile device **108** is allowed access to the area **102** can be made by the mobile device **108**. Accordingly, access control (i.e., the determination of whether to grant access) can be moved from a controller (or other hardware device(s) seen in previous approaches) to the mobile device **108** itself. Accordingly, where access control is implemented on a mobile device **108** in accordance with embodiments of the present disclosure, facilities need not employ complex physical access controllers capable of managing access only to a limited number of access points (e.g., doors) as in previous approaches. Instead, a remote and/or virtual (e.g., cloud-based) controller can be implemented, for instance, in conjunction with one or more relays (such as those previously discussed).

Determining whether the user is allowed access to the area can include determining whether the user (via the mobile device **108**) has been provided with (or otherwise received) a digital identity. A digital identity can correspond to the physical identity of the user. The digital identity can be unique to the mobile device **108** of the user (e.g., one digital identity per mobile device of the user). The digital identity can be (or be a portion of) an app, for instance (e.g., executable instructions stored on a computer-readable medium).

In some embodiments, the digital identity can be a permanent digital identity. A permanent digital identity can be a digital identity that does not expire. For example, a permanent digital identity can be sent to the mobile device **108** of a user who is an employee that works in the facility.

The employee can utilize the permanent digital identity until the employee is no longer employed at the facility.

In some embodiments, the digital identity can be a temporary digital identity. A temporary digital identity can be a digital identity that expires after a set period of time. For example, a temporary digital identity can be sent to the mobile device **108** of a user who is a visitor or guest at the facility. After the set period of time, the visitor/guest's temporary digital identity can expire, and the visitor/guest can lose access to the building (or to particular areas of the building). In some embodiments, the digital identity can be shared with a building management system. The building management system can allow management (e.g., monitoring and/or control) of the facility.

Thus, determining whether the user of the mobile device **108** is allowed access to the area **102** can include determining whether the user is allowed access at the particular time that the user is in proximity to the area **102**. The time can refer to the time of a day and/or the day of a week, for instance, though embodiments of the present disclosure are not so limited.

A digital identity can be associated with (e.g., assigned) access rights. Access rights assigned to a digital identity can vary from one user to another. Access rights, as used herein, can include information describing a user's ability to access different areas of the facility **101**. For example, a supervisory employee may be able to access more areas of a facility than a lower level employee.

In some embodiments, the access rights can be preconfigured access rights. For example, lower level employees can be given an access level that grants an employee access to lower security areas of a facility, whereas higher level employees can be given an access level that allows those higher level employees access to areas with higher security restrictions. As an additional example, access levels can be preconfigured based on the position the employee holds (e.g., a secretary can receive a different access level than a building technician).

In some embodiments, the access rights can be customized access rights. Customized access rights can include access rights that are customized for an individual user. For example, a user can receive access to areas A, B, C, and E, but not area D. As another example, a user can receive access to a number of areas of a building that do not fall within a preconfigured access level.

In some embodiments, a digital identity may expire after a particular period of time (e.g., one day). In some embodiments, a digital identity may expire based on a location of the mobile device **108**. For example, a digital identity may expire when a user visiting the facility **101** exits the facility **101**. As the digital identity expires, so too can the access rights associated with it.

Some embodiments calling for enhanced security can verify that the mobile device **108** to which the digital identity has been provided is indeed possessed by the correct user (e.g., the user allowed access). For example, the user can be authenticated to the mobile device **108**. Such authentication can be carried out responsive to a prompt issued by the mobile device **108**. In some embodiments, authenticating the user to the mobile device **108** can include receiving one or more inputs made by the user. In some embodiments, input(s) can include PINs, codes, patterns, etc. In some embodiments, inputs can include one or more biometric inputs. A biometric input can include a fingerprint scan, a facial scan, etc., though it is to be understood that embodiments of the present disclosure are not limited to particular biometric input(s).

Embodiments of the present disclosure can provide a notification responsive to a determination that the user is not allowed access to the particular area **102**. In some embodiments, a notification can be provided to the mobile device **108**. Such a notification may read “you have entered a restricted area, please turn around,” for instance. In some embodiments, a notification can be provided to a computing device associated with a security system of the facility. The computing device can be the ACS **107** in some embodiments. Once received, such a notification may prompt (or cause) the dispatch of security personnel to make contact with the carrier of the mobile device **108**.

Notifications can be provided in accordance with embodiments herein for other reasons. For instance, a notification can be provided to the computing device associated with the security system of the facility **101** responsive to a determination that a location functionality of the mobile device **108** is deactivated. The location functionality may include the functionality allowing the mobile device **108** to communicate with the beacons **106**, for instance, (e.g., Bluetooth, WiFi, etc.). In some embodiments, a notification can be provided to the ACS **107** responsive to a loss of a communication between the ACS **107** and the mobile device **108** (e.g., because of a deactivation of a communication functionality of the mobile device **108**). In some embodiments, a notification can be provided to the ACS **107** responsive to a determination that the mobile device **108** did not establish a communication with one or more of the beacons **106** associated with the door **105** before entering the area **102**. In some embodiments, a notification can be provided to the ACS **107** responsive to a determination that the mobile device **108** was purposely (e.g., due to power off) or accidentally (e.g., due to expiration of battery) deactivated. In such cases, occupancy of the user in the area **102** can be determined using one or more devices of the facility other than the beacons **106**. Such devices can include, for example, infrared counting beams, occupancy detectors, cameras, etc.

In some embodiments, controlled access to the area **102** can involve the utilization of a “virtual turnstile” in which the mobile device **108** is determined to have gone in through the door **105** and out through the door **105** to arrive in the area **102**. In such embodiments, a subset (e.g., three) of the beacons **106** may be used. For example, a communication established between the mobile device **108** and a first beacon **106-1** can indicate that the user carrying the mobile device **108** potentially intends to enter the area **102** via the door **105**. Such a communication is illustrated in FIG. 1B. A second communication can be established between the mobile device **108** and a second beacon **106-2** as the user approaches the door **105**. Such a communication is illustrated in FIG. 1C.

FIG. 1C illustrates the system **100** for access control via a mobile device **108** wherein the mobile device **108** is located at a second location in accordance with one or more embodiments of the present disclosure. As shown, the second location is closer to the door **105** than the first location (the distance from the first location to the door exceeds the distance from the second location to the door). Subsequent to the first communication between the mobile device **108** and the first beacon **106-1**, a communication established between the beacon **106-2** indicates that the user is approaching the door **105** with the intent to enter the area **102**. If the user is determined to be allowed access to the area **102**, the mobile device **108** and/or the ACS **107** can transmit a signal (e.g., a control signal) to the relay **104** associated with the area **102** to allow access. In an example, the relay

104 can be responsible for physically locking the door **105** to the area **102** and the signal causes the relay **104** to change from a locked mode to an unlocked mode. Thus, the relay **104** can grant the user access to the area **102** responsive to a determination by the mobile device **108** and/or the ACS **107** that the user is allowed access.

FIG. 1D illustrates the system **100** for access control via a mobile device **108** wherein the mobile device **108** is located at a third location in accordance with one or more embodiments of the present disclosure. Once inside the area **102**, the mobile device **108** can establish a communication with a third beacon **106-3** interior to the area **102** thereby apprising the ACS **107** that the user has indeed entered and is now occupying the area **102**. In some embodiments, the mobile device **108** is determined to be located in the area responsive to the first communication, the second communication, and the third communication, in that order.

In some embodiments, the relay **104** can be configured to deny the user access to the area **102** responsive to a failure of communication between the mobile device **108** and the first beacon **106-1**, a failure of communication between the mobile device **108** and the second beacon **106-2**, or a determination by the mobile device **108** that the user is not allowed access to the area **102** based on the digital identity.

When the user leaves the area **102**, the process can be reversed. For instance, a fourth communication between the mobile device **108** and the third beacon **106-3** can be established subsequent to the third communication (which was also between the mobile device **108** and the third beacon **106-3**). A fifth communication between the mobile device **108** and the second beacon **106-2** can be established subsequent to the fourth communication, and a sixth communication between the mobile device **108** and the first beacon **106-1** can be established subsequent to the fifth communication.

FIG. 2 illustrates a mobile device **208** in accordance with one or more embodiments of the present disclosure. The mobile device **208** can be a computing device. The mobile device **208** can include a memory **212** and a processor **210** configured to execute executable instructions stored in the memory **212** to perform various examples of the present disclosure, for example. That is, the memory **212** can be any type of non-transitory storage medium that can be accessed by the processor **210** to perform various examples of the present disclosure. For example, the memory **212** can be a non-transitory computer readable medium having computer readable instructions (e.g., computer program instructions) stored thereon that are executable by the processor **210**.

The memory **212** can be volatile or nonvolatile memory. The memory **212** can also be removable (e.g., portable) memory, or non-removable (e.g., internal) memory. For example, the memory **212** can be random access memory (RAM) (e.g., dynamic random access memory (DRAM) and/or phase change random access memory (PCRAM)), read-only memory (ROM) (e.g., electrically erasable programmable read-only memory (EEPROM) and/or compact-disc read-only memory (CD-ROM)), flash memory, a laser disc, a digital versatile disc (DVD) or other optical storage, and/or a magnetic medium such as magnetic cassettes, tapes, or disks, among other types of memory.

Further, although memory **212** is illustrated as being located within the mobile device **208**, embodiments of the present disclosure are not so limited. For example, memory **212** can also be located internal to another computing resource (e.g., enabling computer readable instructions to be downloaded over the Internet or another wired or wireless

connection). In some embodiments, the memory **212** and/or the processor **210** can be located in the ACS **107**.

In addition to, or in place of, the execution of executable instructions, various examples of the present disclosure can be performed via one or more devices (e.g., one or more controllers) having logic. As used herein, "logic" is an alternative or additional processing resource to execute the actions and/or functions, etc., described herein, which includes hardware (e.g., various forms of transistor logic, application specific integrated circuits (ASICs), etc.), as opposed to computer executable instructions (e.g., software, firmware, etc.) stored in memory and executable by a processor. It is presumed that logic similarly executes instructions for purposes of the embodiments of the present disclosure.

Although specific embodiments have been illustrated and described herein, those of ordinary skill in the art will appreciate that any arrangement calculated to achieve the same techniques can be substituted for the specific embodiments shown. This disclosure is intended to cover any and all adaptations or variations of various embodiments of the disclosure.

It is to be understood that the above description has been made in an illustrative fashion, and not a restrictive one. Combination of the above embodiments, and other embodiments not specifically described herein will be apparent to those of skill in the art upon reviewing the above description.

The scope of the various embodiments of the disclosure includes any other applications in which the above structures and methods are used. Therefore, the scope of various embodiments of the disclosure should be determined with reference to the appended claims, along with the full range of equivalents to which such claims are entitled.

In the foregoing Detailed Description, various features are grouped together in example embodiments illustrated in the figures for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the embodiments of the disclosure require more features than are expressly recited in each claim.

Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

What is claimed:

1. A non-transitory computer-readable medium having instructions stored thereon executable by a processor to:

track a location of a mobile device in a facility based on communications between the mobile device and a plurality of beacons located in the facility, wherein the mobile device includes a display and wherein the mobile device is associated with a particular user having access rights associated with the facility; determine that the mobile device is located in a particular area of the facility;

determine whether the particular user is allowed access to the particular area based on the access rights;

provide a user notification on the display of the mobile device responsive to a determination that the particular user is not allowed access to the particular area; and

provide a deactivation notification to security personnel responsive to a determination that a location functionality of the mobile device has been deactivated by the particular user.

2. The medium of claim **1**, wherein the user notification includes a text based message that notifies the particular user that the particular user is not allowed access to the particular area.

3. The medium of claim **1**, wherein the user notification includes a text based message that instructs the particular user to leave the particular area.

4. The medium of claim **1**, further comprising:

provide a security notification to security personnel responsive to the determination that the particular user is not allowed access to the particular area.

5. The medium of claim **1**, wherein the security notification includes a text based message that notifies the security personnel that the particular user has entered the particular area.

6. The medium of claim **5**, wherein the security notification is provided to a computing device associated with the security personnel.

7. The medium of claim **1**, wherein the deactivation notification is provided to a computing device associated with the security personnel.

8. The medium of claim **1**, wherein the instructions include instructions to provide a loss of communication notification to the security personnel responsive to a loss of a communication with the mobile device.

9. The medium of claim **1**, wherein the instructions to determine that the mobile device is located in the particular area of the facility include instruction to determine that the mobile device is located in the particular area of the facility based on a communication between the mobile device and one or more of the plurality of beacons located in the facility.

10. The medium of claim **1**, wherein the plurality of beacons include:

a first beacon exterior to the particular area of the facility located a first distance from a door to the particular area;

a second beacon exterior to the particular area of the facility located a second distance from the door to the particular area, wherein the first distance exceeds the second distance; and

a third beacon interior to the particular area of the facility; and

wherein the instructions include instructions to track the mobile device based on communications between the mobile device and the first beacon, the second beacon, and the third beacon.

11. The medium of claim **10**, wherein the instructions include instructions to determine that the mobile device is located in the particular area responsive to:

a first communication between the mobile device and the first beacon;

a second communication between the mobile device and the second beacon subsequent to the first communication; and

a third communication between the mobile device and the third beacon subsequent to the second communication.

12. A system for providing access control in a facility via a mobile device of a user, comprising:

a plurality of beacons located in the facility;

a mobile device associated with a user of the facility, the mobile device includes a display and is configured to: store a digital identity; and

communicate with the plurality of beacons;

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an access control system configured to:

track a location of the mobile device in the facility based on communications between the mobile device and the plurality of beacons located in the facility;

determine that the mobile device has validly traveled to a particular area of the facility when the location of the mobile device is identified at a first location farther from the particular area of the facility and then at a second location closer to the particular area of the facility, and in that order;

determine whether the user is allowed access into the particular area of the facility based on a determination that the mobile device has validly traveled to the particular area of the facility and the user has pre-assigned access rights;

provide a user notification on the display of the mobile device of the user responsive to a determination that the user is not allowed access to the particular area; and

provide a deactivation notification to security personnel responsive to a determination that a location functionality of the mobile device has been deactivated by the user.

13. The system of claim **12**, wherein the user notification includes a word or phrase that notifies the user that the user is not allowed access to the particular area.

14. The system of claim **13**, wherein the user notification includes a word or phrase that instructs the user to leave the particular area.

15. The system of claim **12**, wherein the access control system is further configured to provide a security notification to security personnel responsive to the determination that the user is not allowed access to the particular area.

16. The system of claim **15**, wherein the security notification includes a word or phrase that notifies the security personnel that the user has entered the particular area.

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17. The system of claim **15**, wherein the security notification is provided to a computing device associated with the security personnel of the facility.

18. The system of claim **12**, wherein the mobile device is a smart phone.

19. The system of claim **12**, wherein the mobile device is a wearable device.

20. A method for providing access control in a facility via a mobile device, the method comprising:

tracking a location of the mobile device in the facility based on communications between the mobile device and a plurality of beacons located in the facility, wherein the mobile device includes a display and wherein the mobile device is associated with a particular user having access rights associated with the facility;

determining that the mobile device has validly traveled to a particular area of the facility when the location of the mobile device is identified at a first location farther from the particular area of the facility and then at a second location closer to the particular area of the facility, and in that order;

determining whether the particular user is allowed access into the particular area based on a determination that the mobile device has validly traveled to the particular area of the facility and the user has the access rights;

providing a user notification on the display of the mobile device of the user responsive to a determination that the user is not allowed access to the particular area, wherein the user notification includes a word or phrase that notifies the user that the user is not allowed access to the particular area; and

providing a deactivation notification to security personnel responsive to a determination that a location functionality of the mobile device has been deactivated by the particular user.

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